Deployable graphene-based chemical/biological sensors

NOTE: The Solicitations and topics listed on this site are copies from the various SBIR agency solicitations and are not necessarily the latest and most up-to-date. For this reason, you should use the agency link listed below which will take you directly to the appropriate agency server where you can read the official version of this solicitation and download the appropriate forms and rules.

The official link for this solicitation is: http://www.acq.osd.mil/osbp/sbir/solicitations/index.shtml

Agency:
Department of Defense

Release Date:
November 20, 2013
Branch:
Office for Chemical and Biological Defense

Open Date:
November 20, 2013
Program / Phase / Year:
SBIR / Phase I / 2014

Application Due Date:
January 22, 2014

Solicitation:
2014.1

Close Date:
January 22, 2014
Topic Number:
CBD14-102

Description:
OBJECTIVE: Design and develop a deployable radio frequency (RF) based broadband impedance chemical/biological detection system suitable for field-deployable networks, UAV deployment applications, and stand-alone chemical/biological point detection. DESCRIPTION: Chemical-warfare (CW) agents, Biological Warfare (BW) agents, explosive materials, and toxic industrial chemicals/materials (TIC/TIM) are compounds that can be used as weapons of mass destructions. A priority of the DoD Joint Chemical and Biological Defense Program is development of new and improved chemical and biological sensors. To achieve this objective, innovative materials and designs will be required. Low-cost, radio frequency (RF) wireless chemical sensors and biosensors are expected to have significant applications in defense and homeland security and are ideal for deployment on micro-unmanned aerial vehicles and used in field-deployable networks, and for stand-alone point detection. The outstanding carrier mobility, the excessive large surface area per unit mass and the adjustable surface chemistry make graphene an excellent candidate for chemical/biological sensing. Most of the graphene-based chem/bio-sensing approaches, however, rely on registering the variation of either the DC resistance or the electrochemical surface potential. The major restrictions are chem/bio molecules usually experience transformation (e.g. polarization due to the applied high voltage) at DC or low frequency, and high background noises. In addition, the current techniques confront a number of challenges in recognition, selectivity, spatial resolution and quantification. At radio frequencies, the motion of chem/bio molecules and water masking effects can be largely suppressed, thus reducing background noise and increasing sensitivity. Moreover, interfacial capacitance between the target molecule and graphene surface only becomes pronounced and detectable at RF, providing additional information for detection. This topic seeks

new and innovative approaches to design and develop a deployable radio frequency (RF)-based broadband impedance chemical/biological detection system. Due to time/investment constraints in the Phase I/Phase II SBIR project period-of-performance, the offeror should focus on proof-of-concept using chemical agent simulants with an approach that permits future expansion of the active sensing technology to encompass biological agents in later phases. Such a system is expected to outperform conventional sensors in sensitivity, reliability, selectivity (false-positive/false-negative rates), and high-throughput analysis (rapid response time). Some nerve agents have time-weighted average exposure limits at sub-ppb concentration; thereby, the proposal should target sensing CWAs with sensitivity to sub-ppb (by using CWA simulants in the demonstration.) Methods that only address the chemical/biological agents sensing capability such as conventional monitoring variation of resistance and electrochemical potential are not sufficient to meet the intent of this topic, but could be employed to achieve the end objective. Functionalization of graphene with recognition molecules to achieve selective detection of chemical or biological threat agents is highly desired. RF transmitter and rectenna are needed to be implemented in the system to transmit detected information wirelessly. The system must be easy to use, demonstrate real-time sensing with sub-ppb detection sensitivity capable of selective detection (by using a combination of CWA simulants and interferences, e.g., water vapor) and capable of in-situ multiplexed chemical/biological sensing with no need for sample preparation. The system must also be capable of self-recovery, allow prolonged integration time and continuous monitoring of threat changes in the environment, and be used outdoors. The prototype system is anticipated to be readily remote controlled with a high detection probability (PD) and low false alarm (FA) rate: PD>95% and FA